Interferometric, Tomographic and Geometric Cameras

Presentation for the
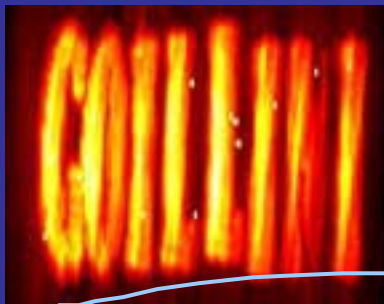## DARPA Camera Ab Initio Workshop
28 April 2003

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Fitzpatrick Center and ECE Department

Duke University

How could cameras be better?

1. They could be more dimensionally aware.
2. They could be more feature aware.
3. They could be more data aware.
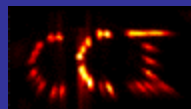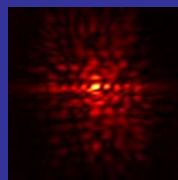4. They could be more array aware.

A Brief History of DISP

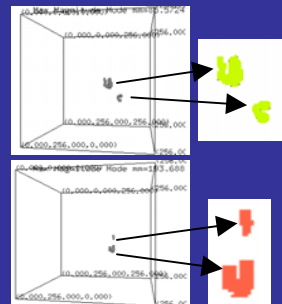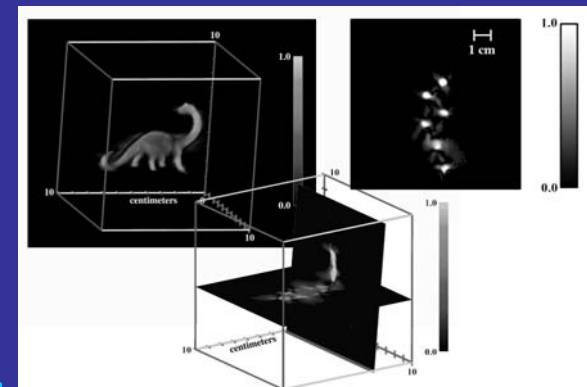1994   1995   1996   1997   1998 1999

Abramson

Cathey

Wolf

Munson

Mertz

Roddier

DISP

Continuing History of DISP

15.0°
12.5°
10.0°
7.5°
5.0°
2.5°

Reconstructed Spatio-Spectral Dist.
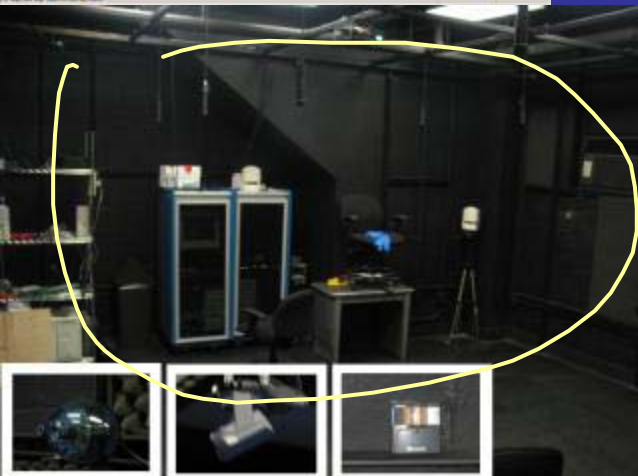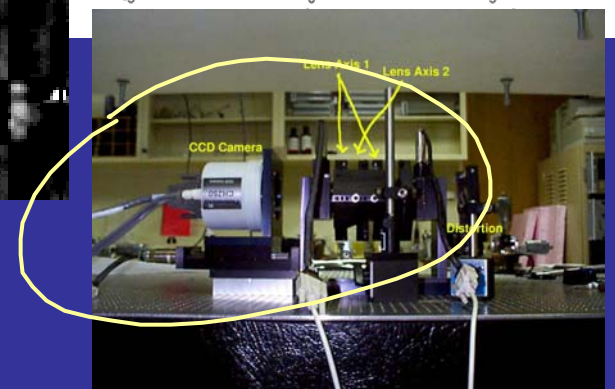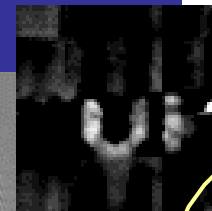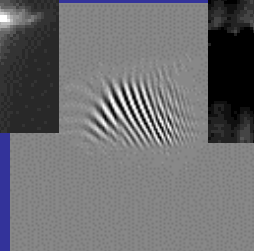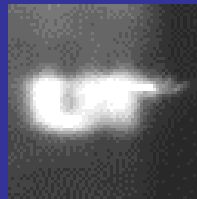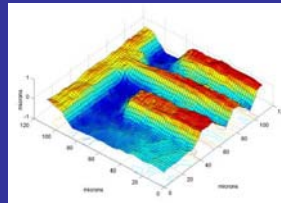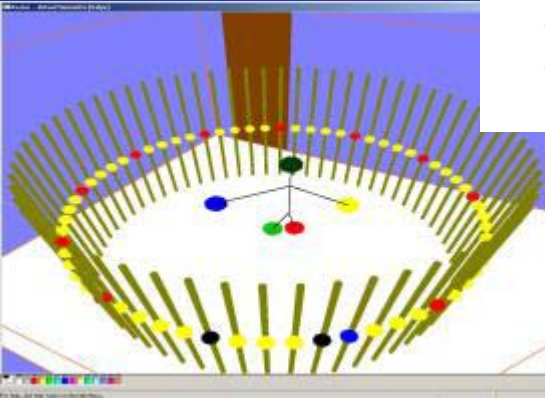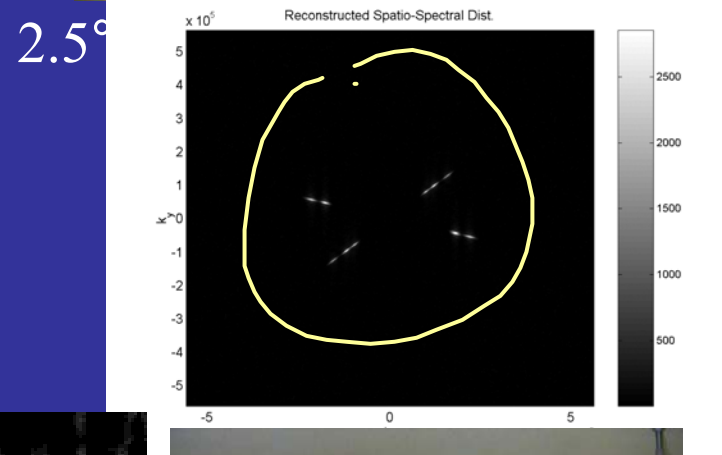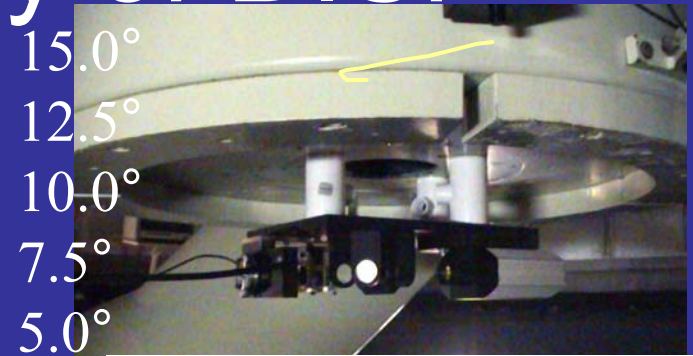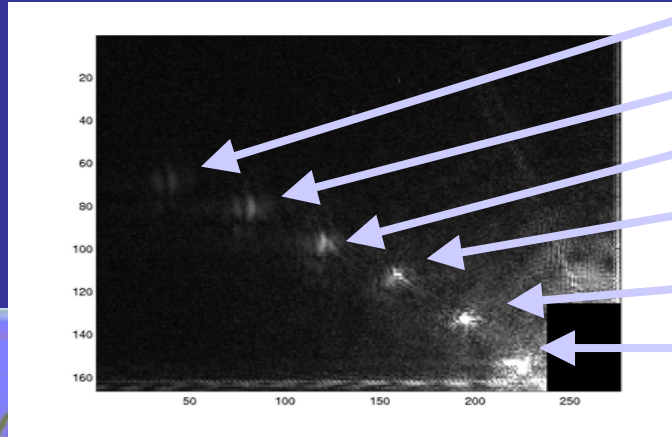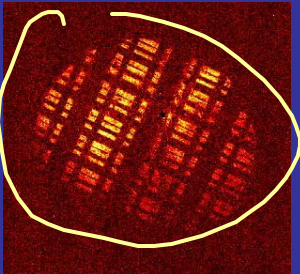
n A, Approved for Public Release, Distribution Unlimited

Conceptual History of DISP

What is an Interferometric Camera?

Measurement sphere

Source

$$J(\Delta \mathbf{s}) = \iiint I_s(\mathbf{r}) e^{j2\pi \frac{\Delta \mathbf{s} \cdot \mathbf{r}}{\lambda}} d^3\mathbf{r}$$
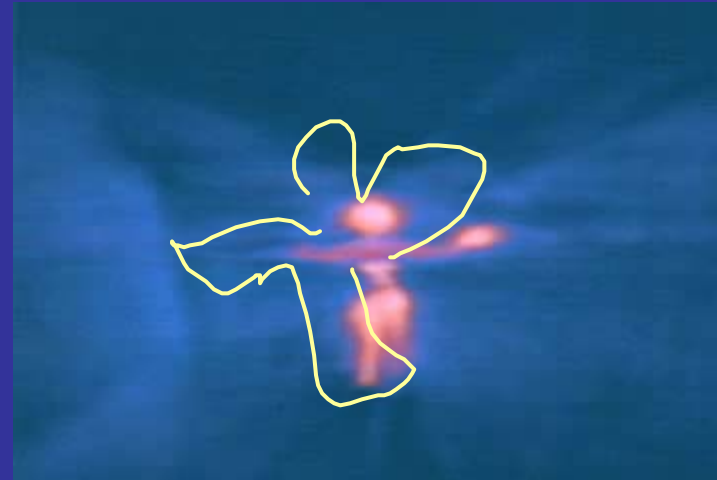
D SP
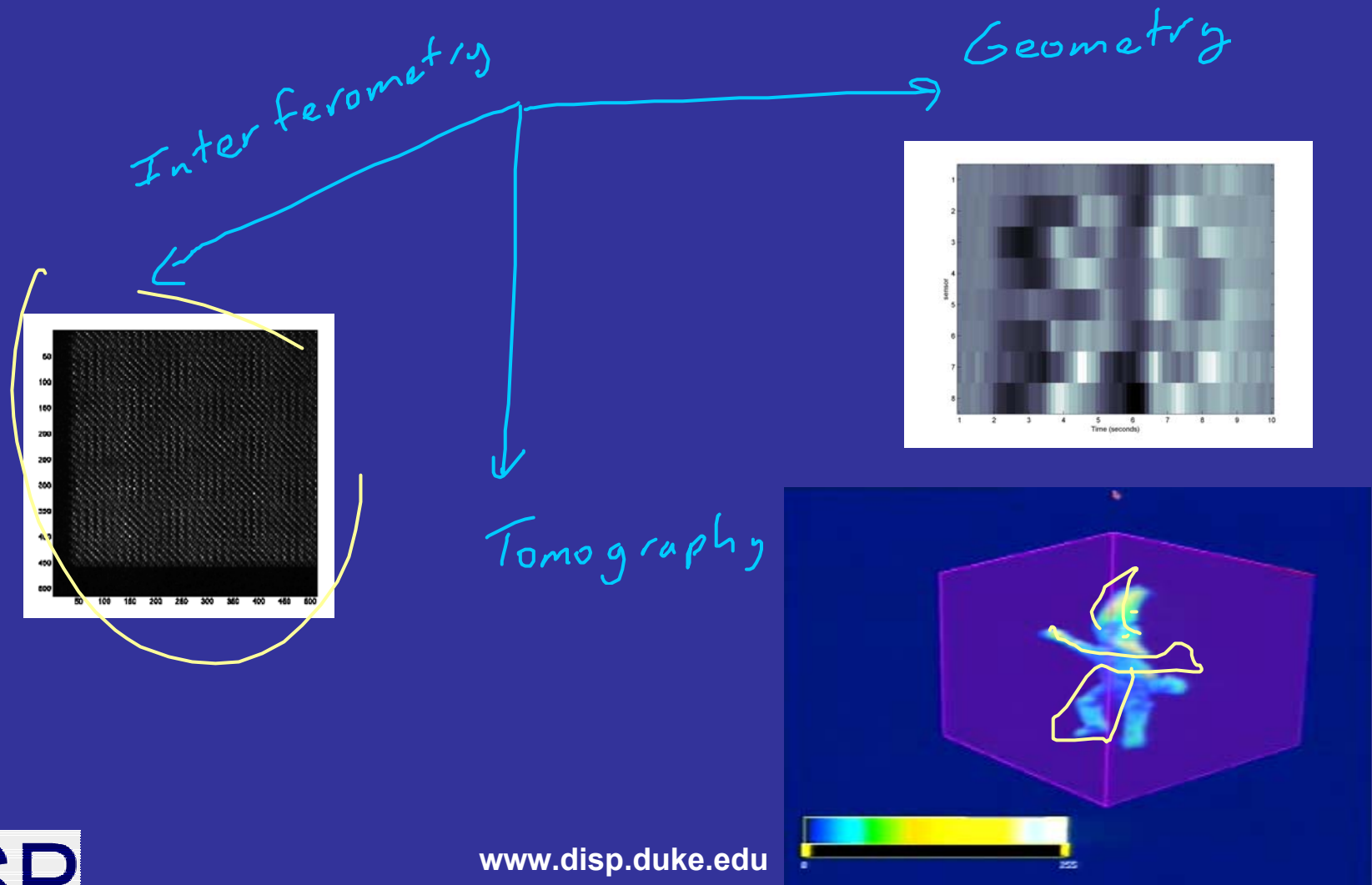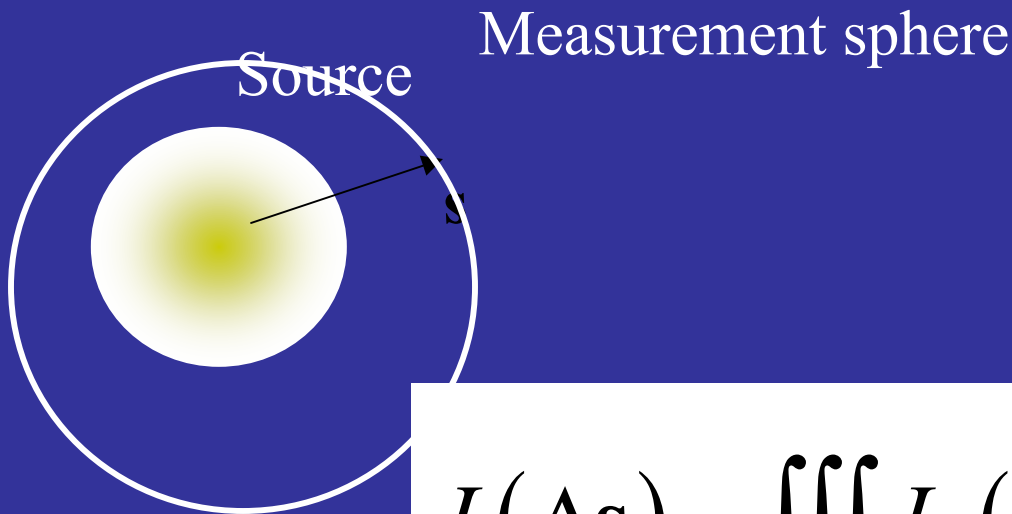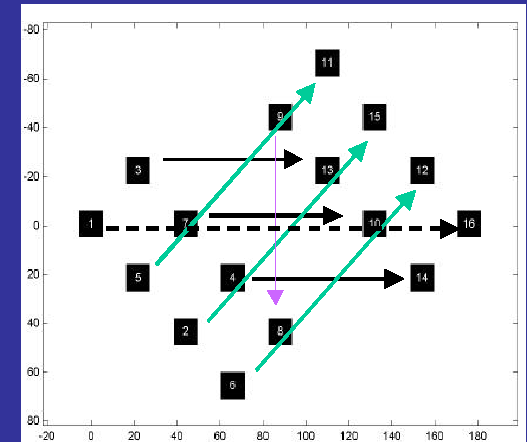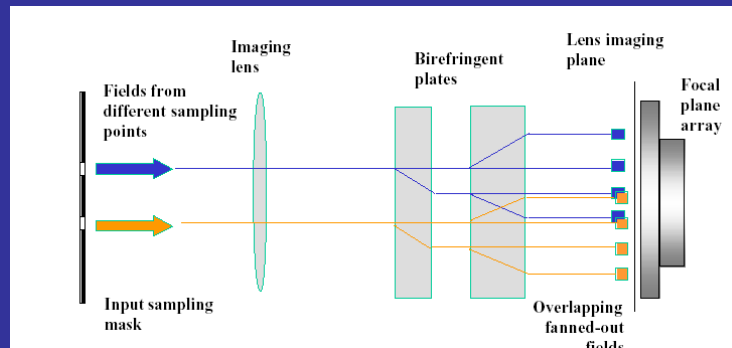
What is an Interferometric Camera?

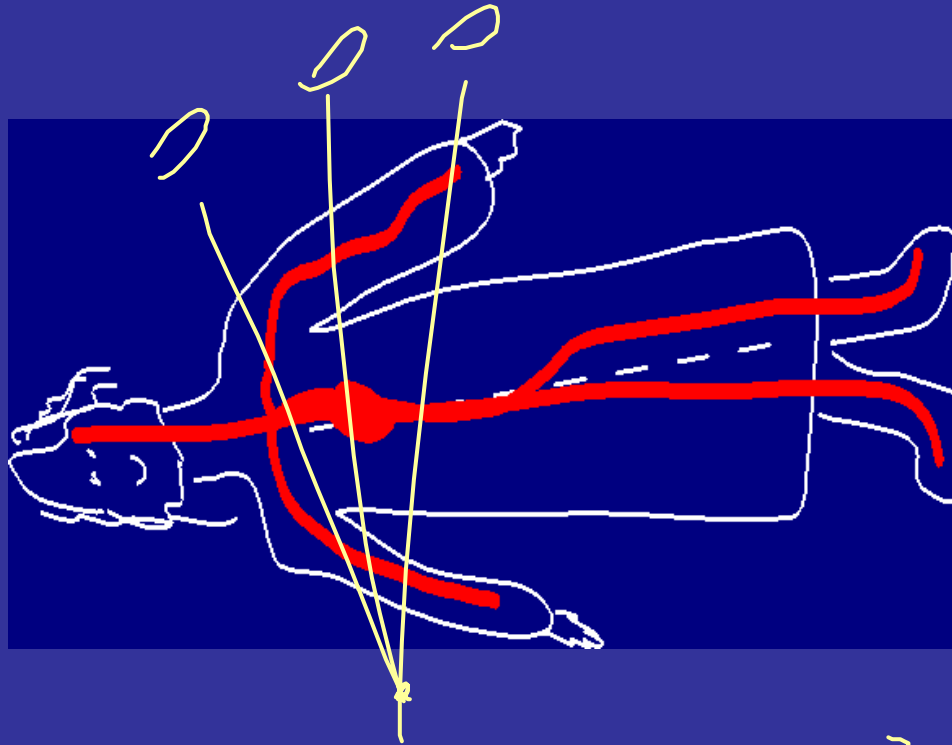$$J(\vec{x}_1, \vec{x}_2) = T\left\{\tilde{J}(x_i', x)\right\}$$

What is a Tomographic Camera?

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DISP

What is Tomography?

$$m = \int_L s(\vec{r}) \, d\vec{r}$$

What is a Geometric Camera?

Camera Classes

Focal

source

measure

$$m = T\{\vec{s}\}$$

Tomographic

$$\cdot \ m = T\{\vec{s}\}$$
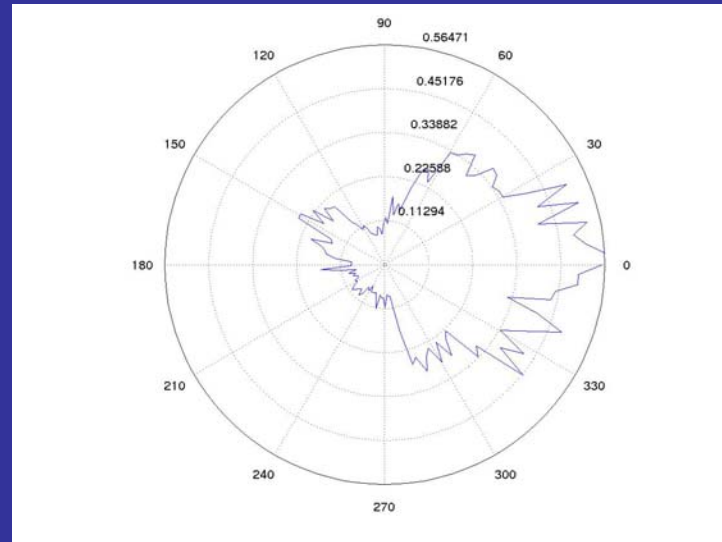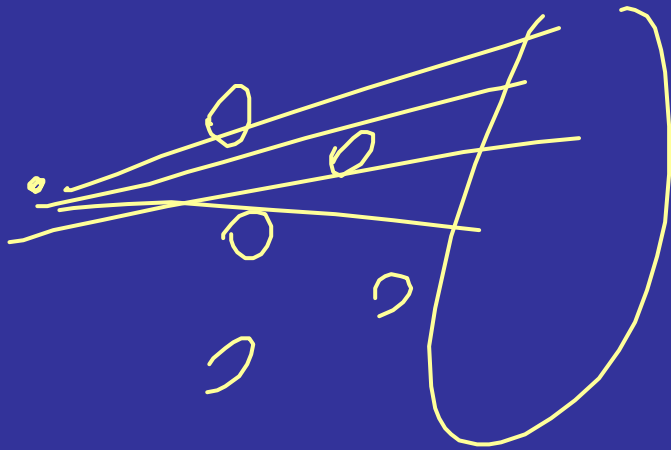
radar

Interferometric

$$m = T\{\vec{s}\}$$
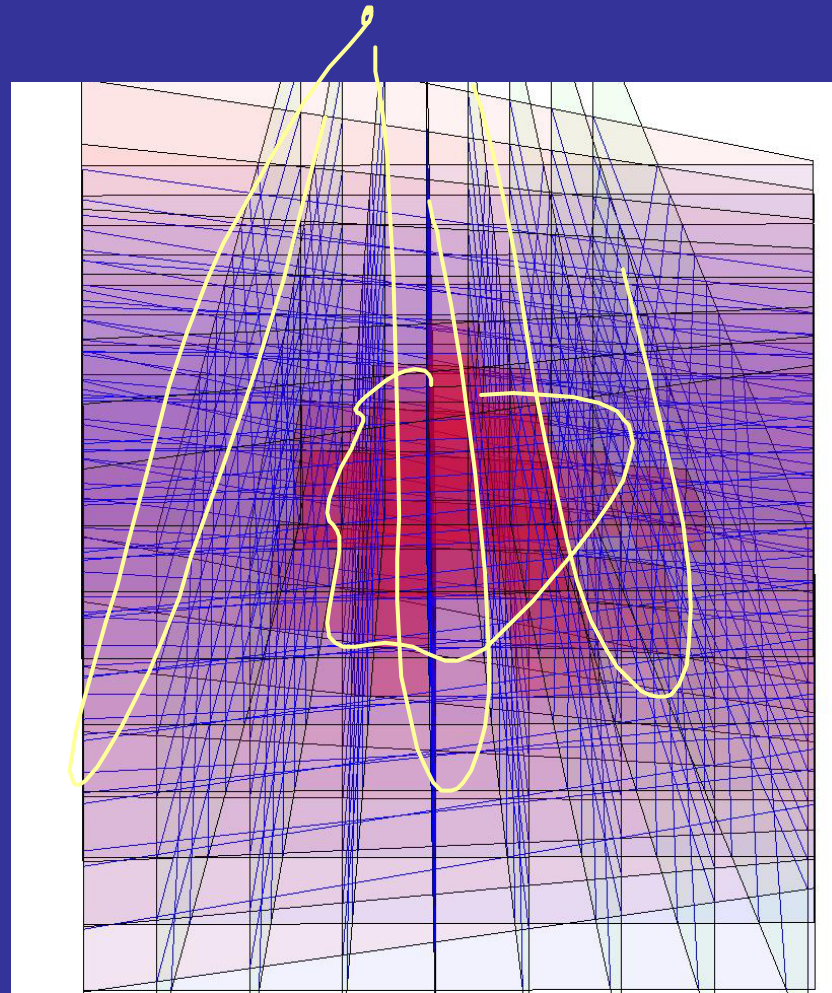
$$\vec{m} = T\{\vec{s}\}$$

F.T.

DISP

What is a Geometric Camera?

What is a Geometric Camera?

feature

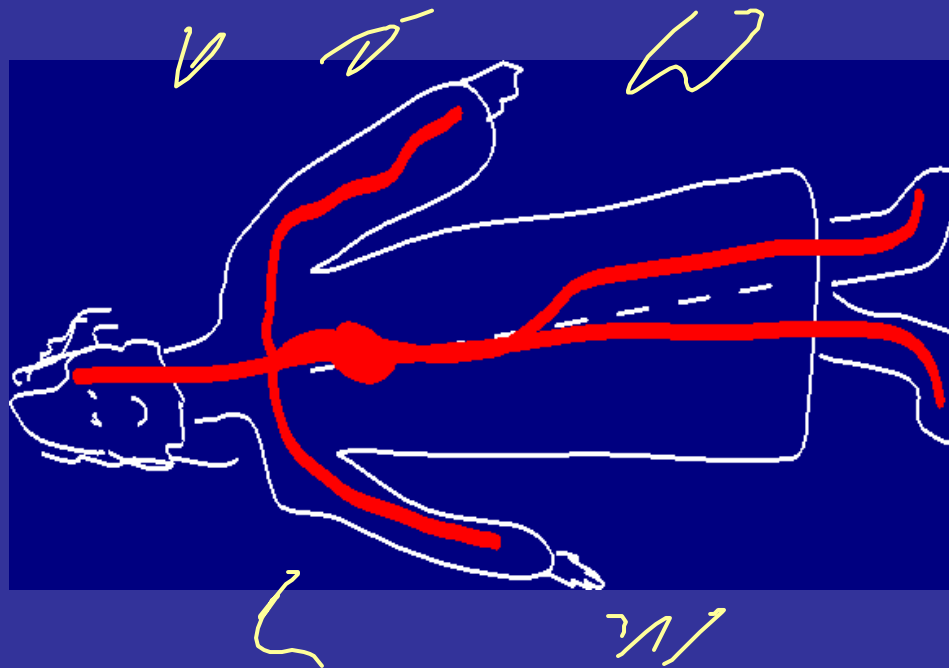# What is a Geometric Camera?

feature

What is a Geometric Camera?

What is a Geometric Camera?

What is Reference Structure Tomography?

$$m(\vec{r}) = \int v(\vec{r}, \vec{r}') \, s(\vec{r}') \, d\vec{r}'$$
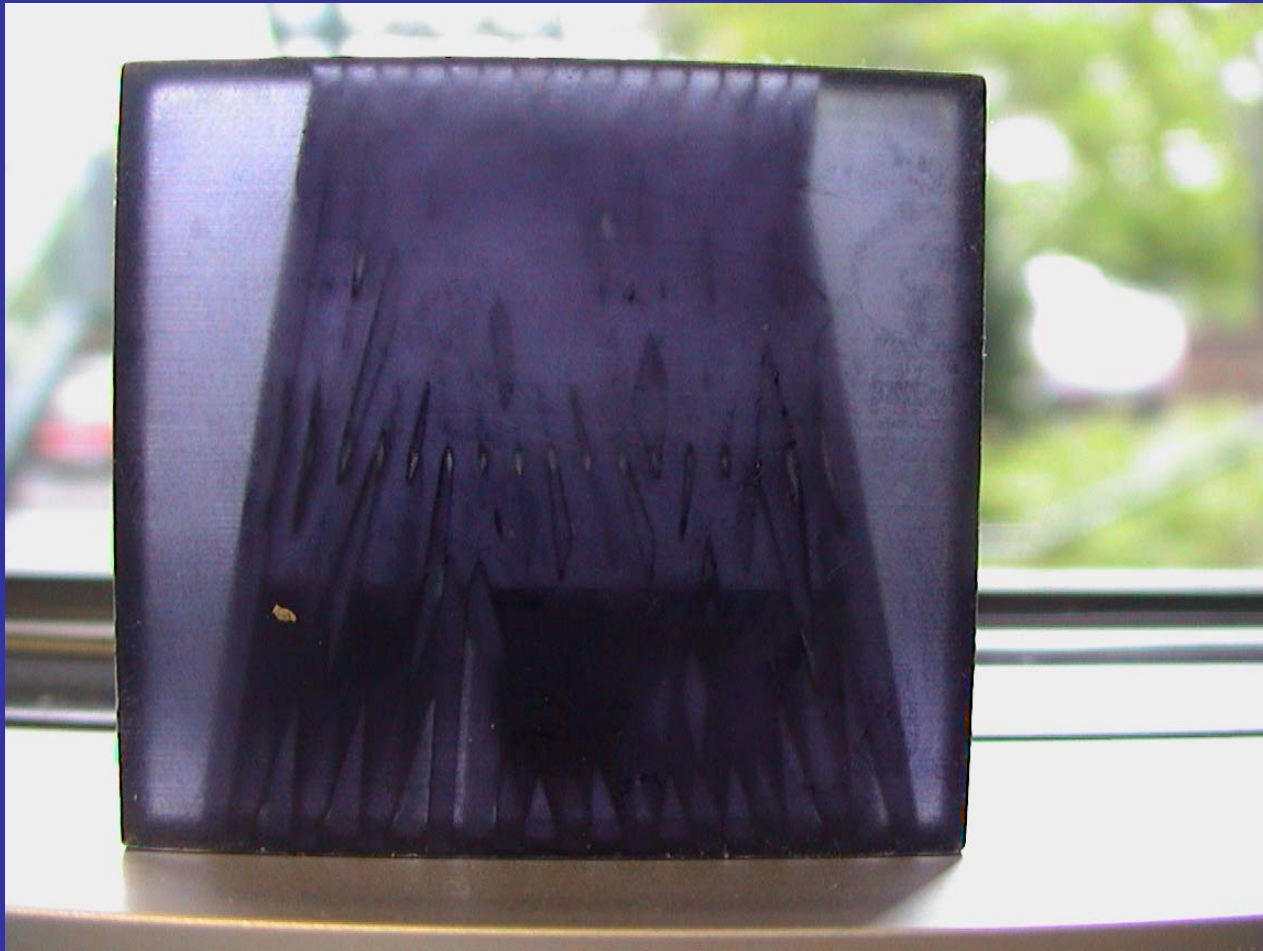
Why RST?

- Scan-Free Multidimensional Imaging
- Direct Parameter Estimation
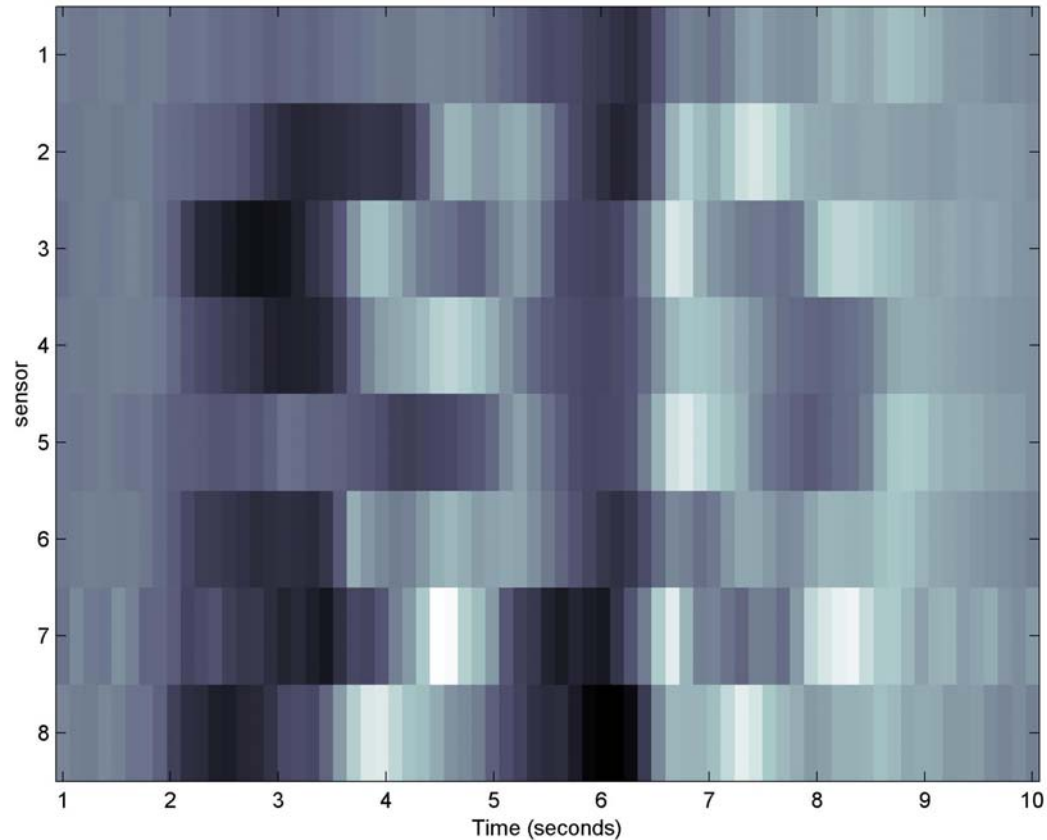- Direct Object Classification

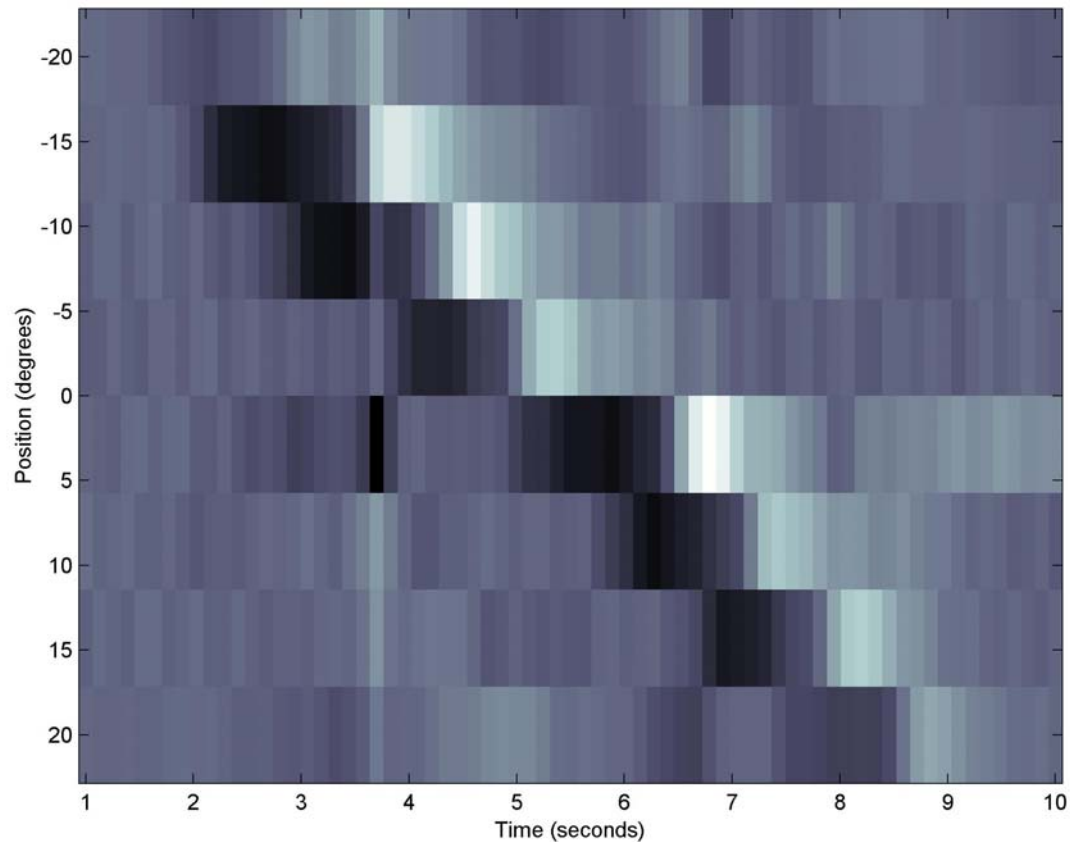# RST vs. Coded Apertures
RST vs. Interferometry
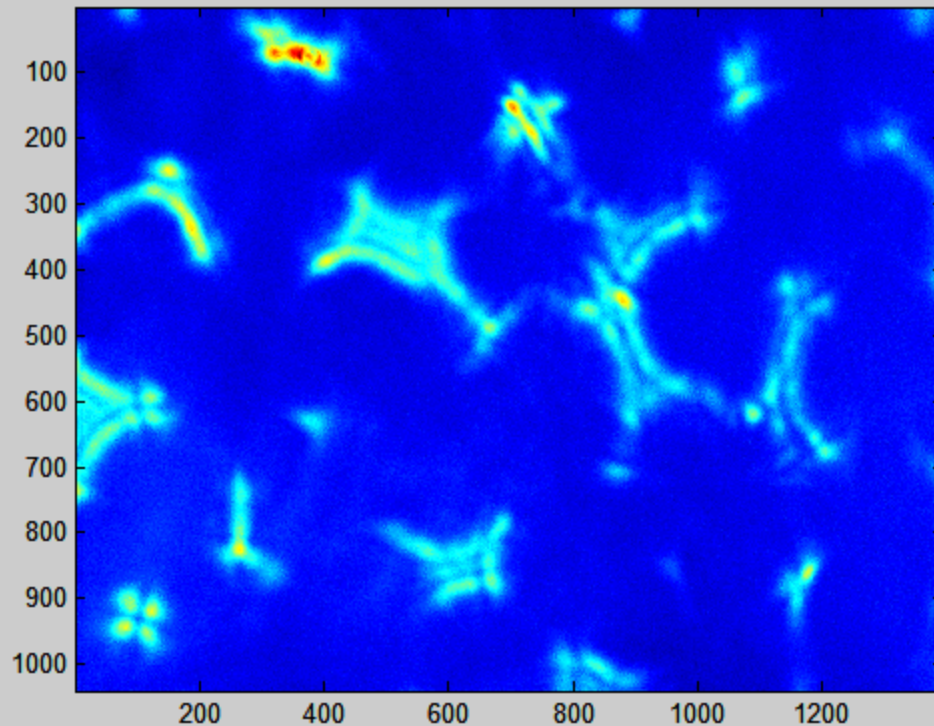
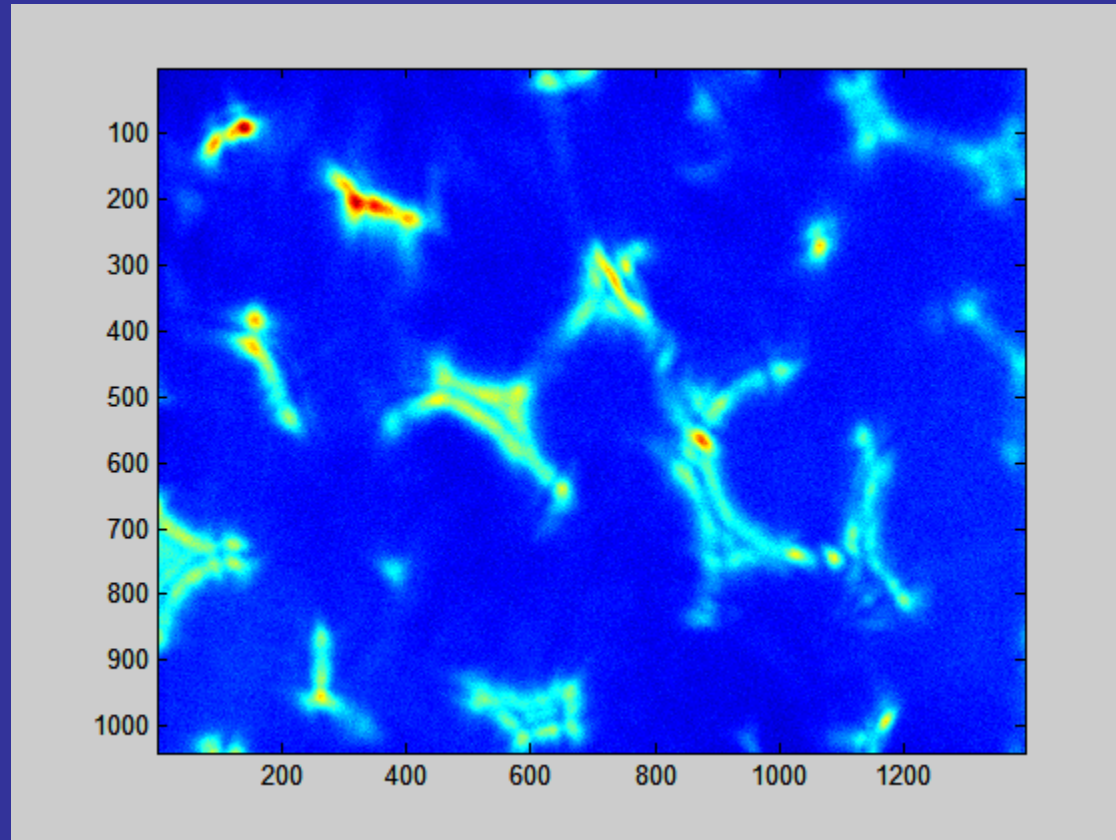$$m = s * a$$

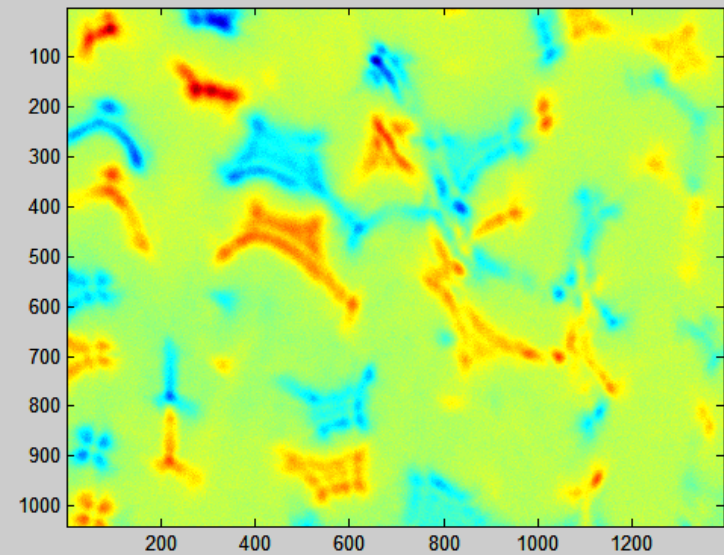# Example: Projection Sensors

DISP

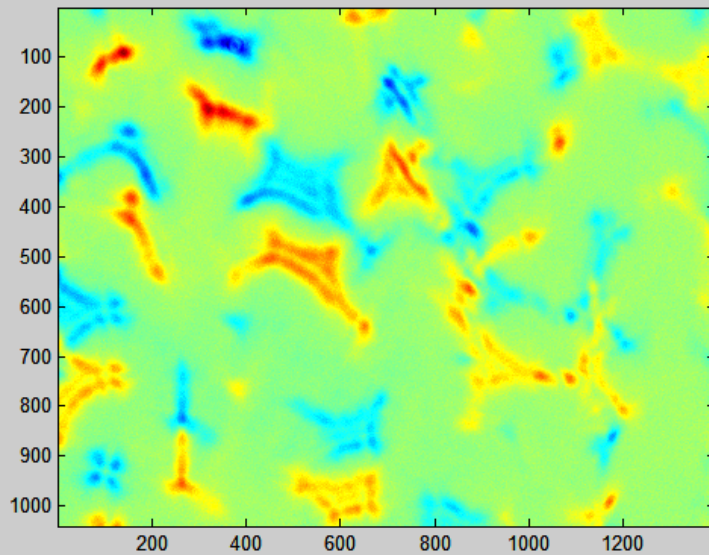# Measurement Space

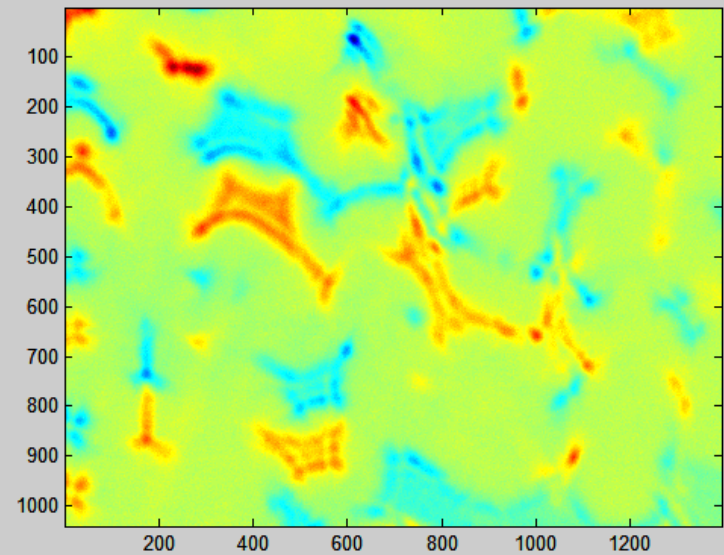# Reconstruction Space
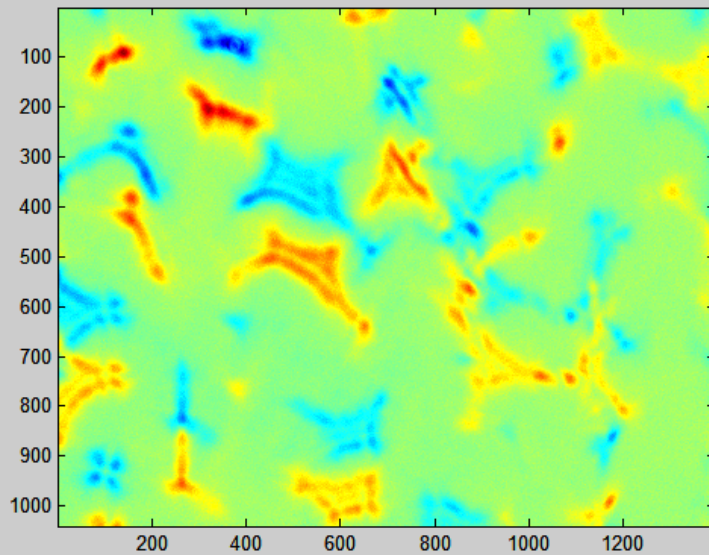
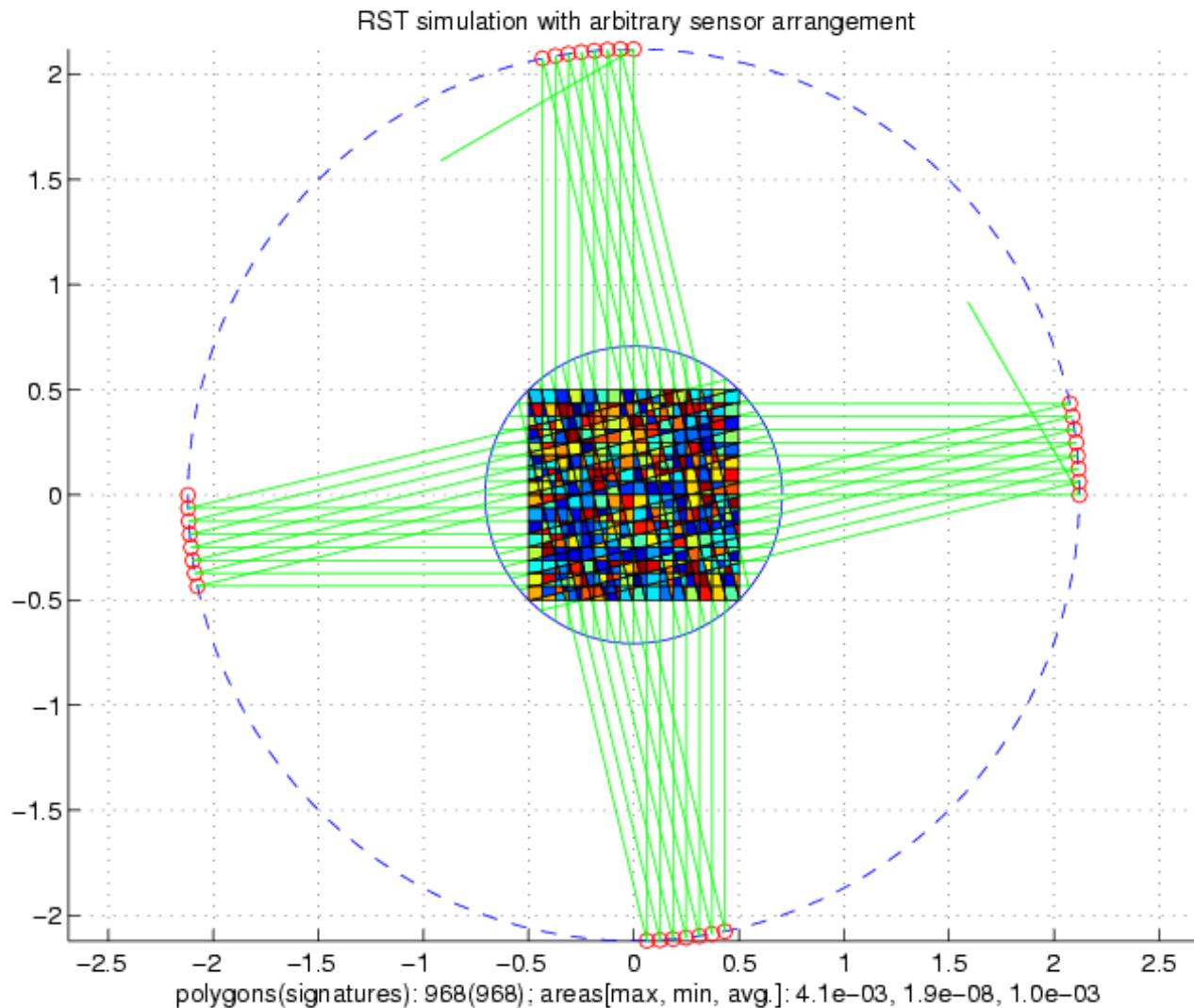# Multidimensional Imaging

Measurement at Voxel 001

Difference between Sensor Field for Voxel 001 and 002 011 and 012

Delta(001,002) and Delta(021, 022)

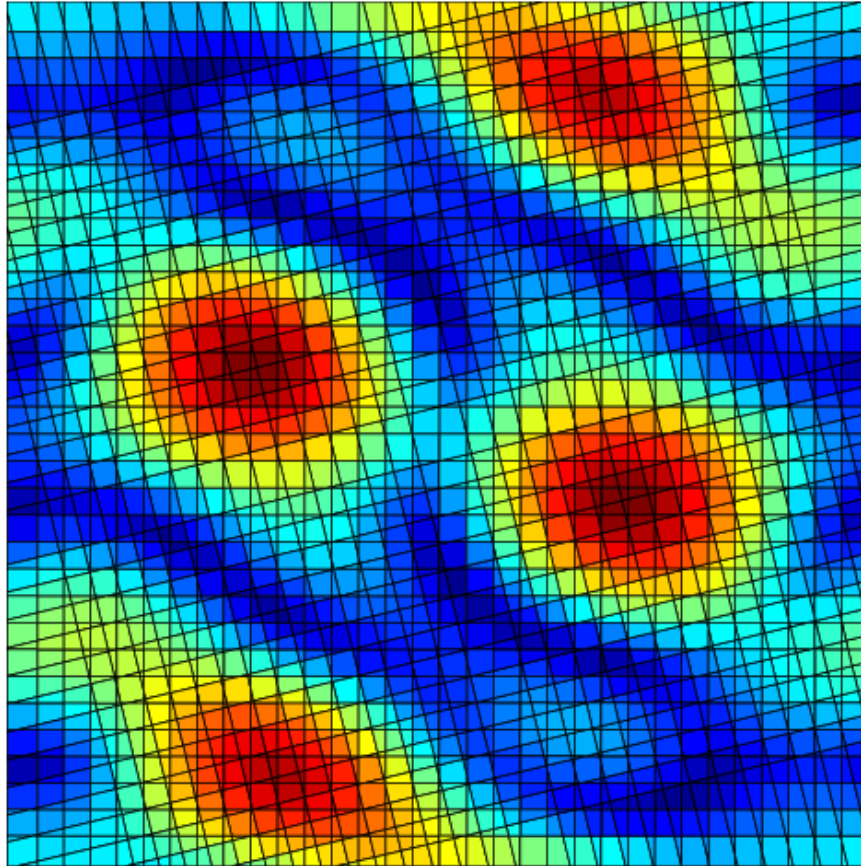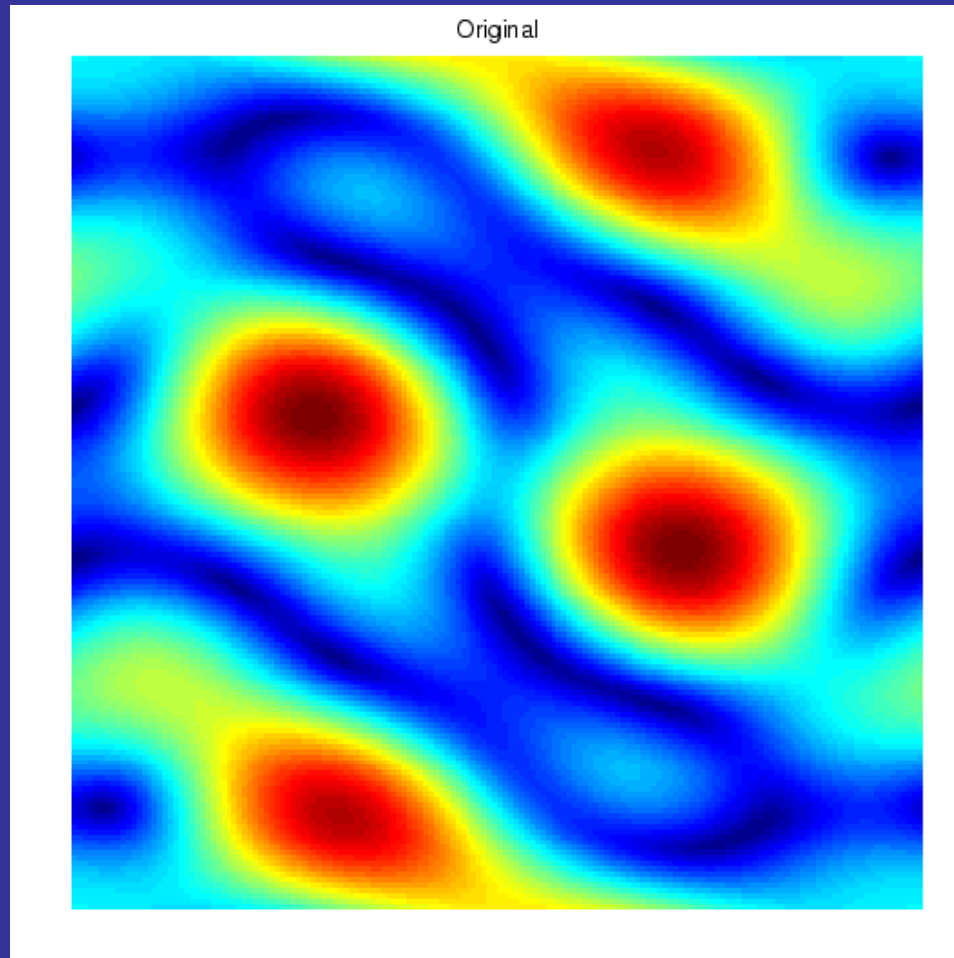# Simulation of Multidimensional Imaging

RST simulation with arbitrary sensor arrangement

polygons(signatures): 968(968); areas[max, min, avg.]: 4.1e−03, 1.9e−08, 1.0e−03

RST Segmentation

Original sectioned by the RST

Original Image

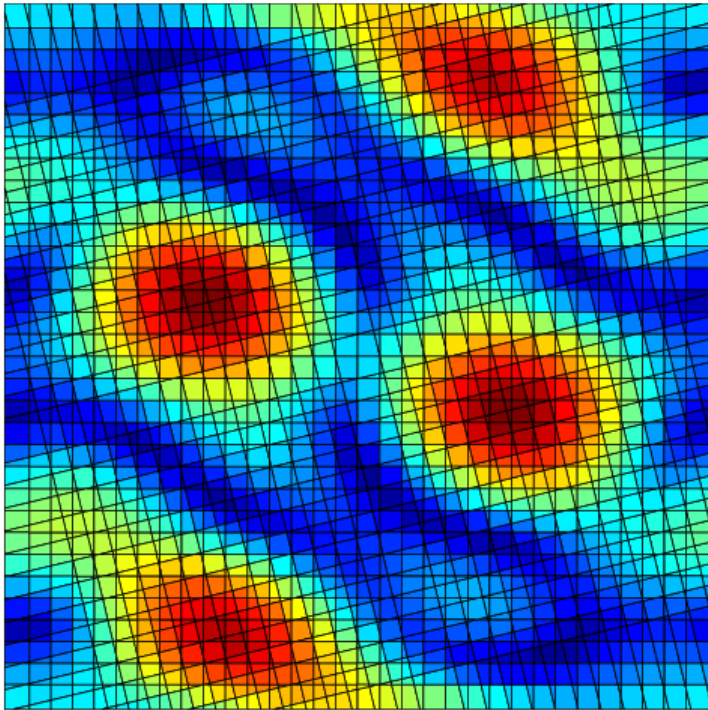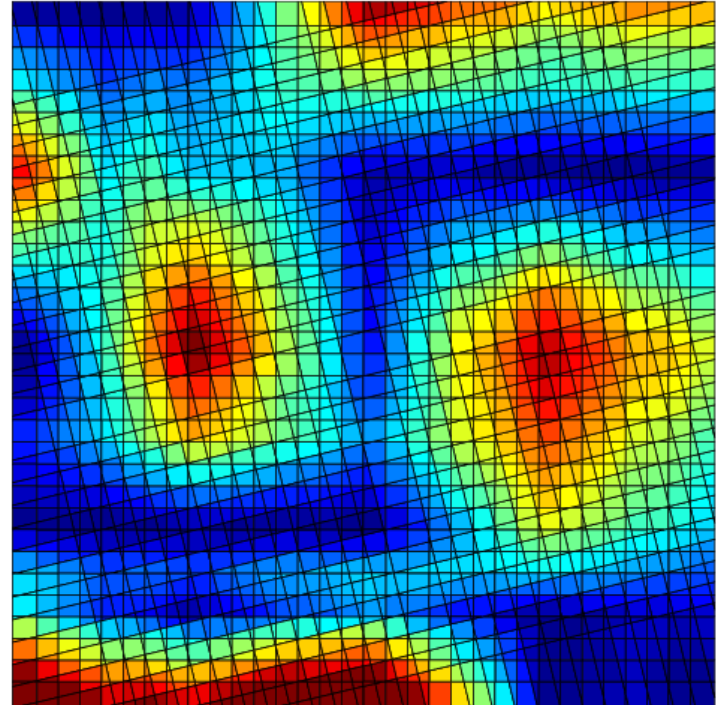Original

Reconstruction

Original sectioned by the RST

Reconstruction

Helmet Cam

Integrated systems